reflected by magnesium carbonate, illuminated by direct sunlight. Repeated measurements of the relative intensities of corresponding portions of these spectra throughout their whole length, and similar comparisons of the spectrum of the magnesium carbonate with the direct spectrum of the source of illumination, have furnished data from which the character of the light sent us from the open sky can be determined, and, in one sense, its color also. The measurements show that the spectrum of the sky is of the same character as that of white light, varying less from the reflection spectrum of a perfectly colorless object than do the spectra of such substances as white paper, sulphate of calcium, carbonate of magnesium, lamp-black, etc. Similar measurements were made of the reflection spectra of Lord Rayleigh's 'blue cloud,' formed by the precipitation of sulphur by hydrochloric acid in a solution of hyposulphite of sodium, and of thin films of antimony oxide. It was found that the same is true of the light reflected by these substances. The blue color of the sky and of other opalescent media is, according to these results, not due to an excess of the more refrangible rays in the light reflected by them, but is of subjective character. This view the author has maintained in a previous paper, in which it was pointed out that a well-known peculiarity of the eye, its rapidly increasing sensitiveness to violet, with decrease of intensity of illumination, is sufficient to account for the appearance of the sky, and of many other objects, without having recourse to the hypothesis of selective reflection. The object of the present paper is the presentation of experimental evidence bearing upon this question. It is to be regretted that Prof. S. P. Langley had left town before this paper was read. A number of those present called attention to the disagreement of the results of Professor Nichols with those obtained by Professor Langley.

Professor Nichols's paper was appropriately followed by that of Prof. C. K. Wead, who exhibited a combined spectro-photometer and ophthalmospectroscope. This instrument, made by the Geneva society, is intended to combine with the least possible duplication of parts, several of the best instruments for the study of spectra. It gives the measure of the relative brightness of the spectra: 1°, by the width of slits or by smoked glasses; 2°, by Nicol prisms outside the collimator; 3°, by combination of the two. Further, it allows: 1°, the mixture of any two spectral colors in any relative intensity, and their comparison with an intermediate spectral color by 'Donder's coupled slits;' 2°, the addition of either the simple or the mixed color of a measured quantity of white light (Glan); 3°, the comparison of the simple or mixed colors of the spectrum with the light from a colored body.

In a paper on weather changes of long period, Mr. H. Helm Clayton of Ann Arbor cited evidence that there are at times slow progressive movements of barometric change, and of temperature from west to east. Mr. Clayton also made an attempt to show a certain periodicity in the character of the weather of the United States during the last year, and claimed to be able to make predictions based on this periodicity for a month in advance. The paper excited considerable adverse criticism.

Two papers by Dr. J. W. Moore of Easton, Penn., were devoted to an explanation of apparatus for classroom demonstration of electrodynamic phenomena. A paper read by Prof. H. W. Eaton of Louisville, on the relation of vanishing and permanent magnetism, contained results of an investigation which he had undertaken at the suggestion of Wiedemann.

Prof. C. J. Reed of Burlington, Io., exhibited a piece of apparatus for classroom demonstration of the laws of falling bodies.

CHEMISTRY IN THE SERVICE OF PUBLIC HEALTH.[1]

In the study of hygiene from the chemical side, we are obliged to consider not only the normal conditions of the earth and atmosphere, but the changes which are brought about by the crowding together of individuals on account of the pursuit of manufacturing industries.

In the service of sanitary science, chemistry has an educational office to fill. The public has very little conception of what the capabilities and limitations of chemistry are. It is hard to make a person believe that water to be analyzed must be brought in a clean vessel, and that the chemist cannot distinguish between the impurities of the water and those of the jug. It is almost impossible for the chemically uneducated public to understand that when chemical action takes place, the properties of the substances concerned are not carried into the product; that because vitriol is used in glucose factories the product does not contain the acid; and the use of aquafortis in making oleomargarine, is equally startling.

There must needs be reformers and philanthropists, but many of these are extremists; and nowhere, more than in sanitary matters, is a little knowledge a dangerous thing. At one time all the evils were attributable to microbes, and at another to sewer-gas. Microbes may be left to the biologists, and possibly sewer-gas as well, since chemists have failed to discover any substances in the gas which could produce the well-known ill effects. In the matter of food adulteration, the origin of the terror is often obvious; thus, that tea is said to be adulterated with prussic acid, arose from the use of Prussian blue in the facing. Chemists are periodically obliged to distinguish between adulterations which are merely falsifications and those which are harmful, and it must be remembered that even the purest commercial products contain small amounts of foreign substances.

It is, perhaps, not altogether to our credit that we so often need the spur of extravagance to lead us to

[1] Abstract of an address delivered before the section of chemistry of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Prof. W. R. NICHOLS, of the Massachusetts institute of technology, Boston, vice-president of the section.

lay before the public the truth with regard to existing evils. An unvarnished statement of things as they really are, cannot awaken that interest which arises when people imagine, after each meal, that they feel the effects of the alum in the bread, or the burning of the vitriol in the glucose adulterated sugar, or the heavy weight of the clay out of which the coffee-berries were moulded. It is certainly an important service to public health, that of investigating the actual state of existing evils; and noble examples of such service are seen in the investigations by the *Lancet* of food sold in London. Another point where chemistry comes advantageously in contact with the public health, is in the suggestion of practical remedies for existing evils: some seem to believe that the proper method is, in all cases, to ascertain the existence of the offence, and then to order its discontinuance; but generally, where the evil has been long growing, and where our pecuniary interests are involved, such summary legislation is, as a rule, unjust.

Lavoisier, Berthollet, and, in more recent times, Frankland and others, have interested themselves in the application of chemistry to sanitary purposes; but Pettenkoffer and Angus Smith have been specially prominent workers in this line. This list shows that able chemists have been willing to devote their time to sanitary chemistry; but how often it is the case, that a brief course in analysis is held to justify a person in acting as an adviser, as the state assayer or public analyst!

Professor Nichols stated that he had been asked, What is sanitary chemistry? Is it any thing more than puttering? as if the problems were all solved, and we had but to follow a mechanical process. Our knowledge of the normal composition of the atmosphere rests upon the analysis of many chemists; but, while we know so much, who knows the bearing upon health of the variations to which the atmosphere is subject? How much, in spite of the work of Professor Remsen, do you know of the organic matter in the air, and the proper methods for its dedetection and estimation? Professor Remsen and others have found that the passage of carbon monoxide through the heated iron of our furnaces is practically of no account; but who can tell us of the composition and amount of the gaseous 'somethings' which make the anthracite-heated atmosphere of our houses so different from that of a house heated by a wood-furnace? It is asserted by some that the day of chemical examinations is passing away, and that the wholesomeness of water will be determined by the biologist, not by the chemist. Without detracting from the present value of biological methods, we cannot believe that they can replace chemical examination for a long time yet: it must first become certain that all the evil effects of impure water are due to the organisms now so eagerly studied. When the biological examination of water has been placed on a firm basis, it will then be necessary to carry out the work begun by Professor Mallet, of discovering the chemical characteristics which belong to waters which a biological examination condemns, and of making these characteristics the basis of future chemical analysis. In the matter of the pollution of streams by sewage, there is much chemical work to be done. The natural purification of streams is admitted to be a fact; but chemists differ as to the extent to which it takes place, and the agencies at work. The action of oxygen has been and is to-day being studied; but clear light will not be obtained so long as we are content to speak of 'organic matter' as though it were a definite something.

Sanitary science comes nearest to the public in the examination of foods and drinks. Chemical examination of such substances has long been provided for by law, and in recent years has seen greatly increased activity. Provision is made on the continent of Europe for such examinations; and there are laboratories at the service of the public, either gratis, or under a tariff often ridiculously low. In this country, more or less stringent laws against adulteration exist; and these laws, in some states, have been made more stringent on account of popular feeling, which was at its height in 1878 and 1879; but the enforcement of such laws is usually in the hands of the state boards of health, which are often hampered by the want of suitable appropriations. As far as Professor Nichols was informed, no laboratories have been established by states or municipalities, where the public can have analyses made either gratis, or for a moderate fee; and it is doubtful how far the establishment of such laboratories is desirable. The laboratories which exist in connection with various educational institutions are probably all that is needed; and there are advantages in securing the co-operation of a number of able chemists, as is done in New York State, and in assigning to each certain descriptions of articles for analysis.

Investigations in sanitary chemistry have been undertaken in the various agricultural and physiological laboratories; but one of the first — if not the first laboratory founded for the investigation of these questions — was that established in Dresden, in January, 1871, under the direction of Dr. Fleck. Among subjects investigated at this institution, were the various methods of water and food analysis, methods of protecting combustible and inflammable material, and the effect of arsenical papers upon the air of rooms. The state board of health of Massachusetts led the way on this side of the water, and the earlier reports of the board contain many papers on similar questions.

The education of those who propose to follow this line of work requires a thorough knowledge of general and analytical chemistry, and of physics. It is quite possible to take a bright lad from the grammar school, or even from the street, and teach him to make analytical determinations with great accuracy; but this does not make a chemist of him. Courses in sanitary engineering in our technical schools have been established, but how far these courses will develop does not yet appear. In order that the student may have an intelligent idea of what questions should be submitted to the chemist, and how the results obtained should be understood, he should

have a good knowledge of the principles of chemistry. Sanitary inspectors should be familiar with certain chemical tests which would enable them to make preliminary examinations, and to determine how far the aid of the chemist is necessary. There is room in the community for a class of persons knowing a little engineering, a little chemistry, a little biology, and a little of other things, an occupation legitimate and honorable, but one which does not justify our calling a person so posted a sanitary engineer, or a chemist.

PROCEEDINGS OF THE SECTION OF CHEMISTRY.

The meeting of the chemical section had an unusually large attendance; and Ann Arbor, not having very many attractions to withdraw the attention of members, allowed all chemists in attendance to be present. The total number of papers presented was small, — in all only seventeen. Of these one was not chemical, one was every thing, one organic, one applied, two mathematical, two pharmaceutical, three theoretical, and six analytical. The meeting, while not brilliant, was respectable, and was remarkable chiefly for the absence of the older and more renowned chemists of the country. It would certainly be an advantage if these would more generally endeavor to attend the meetings of the association, and encourage the younger members by their counsel. Following is a brief synopsis of the more important papers presented: —

Prof. A. B. Prescott gave results of experiments made under his direction, fixing the limits of recovery of certain poisons when mixed with organic matter, such as meat and bread.

Prof. W. A. Noyes read a paper on para-nitrobenzoic sulphunide. This body belongs to the class of sulphunides, the first representative of which was discovered by Fahlberg. The new substance is remarkable, in that it retains the imide grouping peculiar to the sulphunides in its salts. This nitrosulphunide is intensely bitter, while benzoic sulphunide is probably the sweetest substance known.

Dr. H. W. Wiley presented a method of estimating lactic and acetic acids in sour milk or koumiss. The caseine is precipitated by adding an equal volume of strong alcohol to the milk. After filtering, the acid is determined in the filtrate, using phenyl-phthalein as indicator. The same author spoke of the composition of koumiss made from cow's milk. The analyses show a lower percentage of alcohol and lactic acid, and a higher one of milk-sugar and fat, than are found in European samples, whether made from cow or mare's milk. The adulteration of honey was also discussed by Dr. Wiley. The honeys of commerce are found to be largely adulterated. The substances most used for this purpose are, starch-sugar sirup (glucose), cane-sugar, and inverted cane-sugar. Results of numerous analyses made at the department of agriculture were given, and a comparison of American honeys made with those of Europe.

Messrs. H. W. Wiley and F. V. Broadbent described a new method of estimating water in glucose, honeys, etc. Samples are dissolved in alcohol mixed with a weighed portion of sand, and dried. After cooling to 70° C, they are saturated with absolute alcohol, and dried again to constant weight.

Messrs. E. H. Cowles, A. H. Cowles, and C. F. Mabery, presented an important and interesting paper on a new electric furnace, and aluminum alloys made in it. The furnace is of fire-clay. The mass to be acted on is mixed intimately with finely-powdered gas-carbon, and is placed in the break between the two electrodes, which are inserted in the two ends of the furnace, and connected with a powerful dynamo-electric machine. The mass to be reduced is surrounded with coarsely pulverized charcoal, to prevent the heat produced from attacking the fire-clay furnace. The temperature of the furnace is high enough to produce an alloy of copper and aluminum, when the aluminum is present in the state of oxide, or even of silicate. The aluminum alloys produced by this method cost much less than when made in the old way. The five per cent aluminum alloy is a close approximation in color to 18 carat gold, and does not readily tarnish. Its tensile strength, in the form of castings, is equivalent to a strain of 68,000 lbs. to the square inch. An alloy containing two or three per cent aluminum is stronger than brass, possesses great permanency of color, and would make an excellent substitute for that metal. The effect of silicon in the small portions, upon copper, is to greatly increase its tensile strength; and copper and silicon alloys are made easily in the furnace. When more than five per cent of silicon is present, the product is extremely brittle. Alloys of copper and boron have also been made. Boron seems to act upon copper as carbon does on iron. A small percentage of boron in copper increases its tensile strength to 50,000 or 60,000 lbs. per square inch, without diminishing to any great extent its conductivity. Aluminum seems to increase very considerably the strength of metals with which it is alloyed. An alloy of copper, nickel, and zinc, containing a small percentage of aluminum, has been named 'Hercules metal,' and withstood a strain of 105,000 lbs. to the square inch. The strength of common brass is doubled by the addition of two to three per cent of aluminum. Alloys of aluminum and iron are obtained, without difficulty, in the furnace. One product was analyzed containing forty per cent of aluminum.

A chemical study of Yucca angustifolia was presented by Miss Helen C. D. Abbott. Besides many of the usual constituents found in plants, the following were detected: manganese in the ash, four fixed oils, a new resin which it is proposed to name yuccal, another new resin which it is proposed to name pyrophaeal, a red crystalline coloring matter, a new gum, four crystalline compounds, and saponin. In